line test circuitry associated with said active splitter circuitry for transmitting a test signal on the line based upon at least one of an event and receipt of a test request signal, said line test circuitry having associated therewith a unique identity code transmitted with the test signal.

REMARKS

Applicants would like to thank the Examiner for the thorough examination of the present application. Several minor amendments to the specification have been made to address inadvertent errors and to present a more consistent format without the introduction of any new matter.

To more readily address minor inconsistencies in the original claims, these original claims are being canceled and new Claims 34 to 63 are being added. The arguments supporting patentability of the new claims are presented in detail below.

I. The New Claims Are Patentable

The Examiner rejected prior independent Claim 1, for example, over the Lechleider et al. patent in view of the Bingel et al. patent. Lechleider et al. discloses a system for estimating the ability of a subscriber loop to support broadband services, and Bingel et al. discloses a system for testing POTS device.

New independent Claim 34 is directed to an active POTS splitter comprising active splitter circuitry to be connected to a subscriber line for separating analog POTS signals from xDSL signals, and line test circuitry associated with the active splitter circuitry for transmitting a test signal on the line based upon at least one of an event and

receipt of a test request signal. In addition, the claim recites that the line test circuitry has associated therewith a unique identity code transmitted with the test signal.

The Lechleider et al. patent discloses a logic device at the subscriber's premises which places a telephone call via a modem, also at the subscriber's premises, to a distant modem at a qualification center. The initial negotiation between the two modems produces information that is used to determine operating conditions that, in turn, are used to determine the viability of depoloying ADSL over the subscriber line. The information derived from the modems is described as analog properties, such as power levels, noise levels, loss levels and far-end echo loss.

The logic device that initiates the call over the modem from the customer's premises is described as:

> "a subscriber personal computer, a Settop Box, a Web TB, or any device capable of placing a modem call. Logic device **102** may also be a test set having a modem and the logic necessary to complete the telephone call that is temporarily placed in the subscriber home **170**." (Col. 4, lines 35-40).

Of interest, nowhere does the Lechleider et al. patent teach or suggest that the logic device and modem are combined with, or part of, an active POTS splitter. The Examiner, of course, recognizes this critical deficiency of Lechleider et al., but cites the Bingel et al. patent as supplying the teaching to selectively modify the circuitry of Lechleider et al. to somehow be combined with active analog splitter circuitry as in the claimed invention.

Applicants respectively assert, that even if there were some proper motivation in the prior art to attempt a selective combination of the disjoint pieces of Lechleider et al. and Bingel et al., such a hypothetical combination would still fail to produce the claimed invention. Bingel et al. fails to specifically disclose any POTS splitter at the subscriber's premises, much less an active POTS splitter combined with test circuitry. Instead, Bingel et al. discloses a POTS splitter only at the central office.

Moreover, the only disclosed line testing in Bingel et al. is based upon a minimum and maximum rate achievable by the modem while a particular POTS device is connected to the subscriber's line. (Col. 3,lines 1-11). There is no teaching or suggestion of circuitry for transmitting a test signal on the line based upon at least one of an event and receipt of a test request signal as in the claimed invention.

Accordingly, it is submitted that new independent Claim 34 is patentable over Lechleider et al. and Bingel et al. New independent Claims 46, 49 and 63 are similar to Claim 34 and are patentable for at least the same reasons. In view of the patentability of the independent claims, it is submitted that their dependent claims, which recite yet further distinguishing features are also patentable. Accordingly, these dependent claims require no further discussion herein.

CONCLUSION

In view of the new claims provided herein and the arguments presented above, it is submitted that all the claims are patentable. Accordingly, a Notice of Allowance is respectfully requested in due course. Should any minor

informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: DIRECTOR, U.S. PATENT AND TRADEMARK OFFICE, WASHINGTON, D.C. 20231, on this 21 day of November, 2001.

MARKED UP VERSION OF SUBSTITUTE SPECIFICATION

IMPROVEMENTS IN, OR RELATING TO TELECOMMUNICATIONS

Field of the Invention

[0001] The present invention relates to:

~~A~~ a POTS splitter, for separating analog~~ue~~ telephony signals from line testing device;

~~A~~ a telecommunications system, incorporating POTS splitters including line testing devices, at customer premises; and

~~A~~ a method of testing a subscriber's line.

Background of the Invention

[0002] A network operator who wishes to introduce a broadband service, for instance xDSL (Digital Subscriber line), must be able to measure certain parameters for a wire pair that is to be used to deliver the service. This is necessary both to ensure that the service can be successfully provided and to enable the network operator to guarantee service quality. There are many advantages if the measurements can be performed on a two sided basis. This means that a signal source capable of transmitting test messages/signals, upon request, must be placed at the customer=s end of the line. The results of applying a test message/signal to the line at the customer=s end are measured at the CO (Central Office) end. The present invention provides an active POTS splitter ("Plain Old Telephony Service" splitter) which includes this testing functionality.

[0003] When delivering a broadband service, such as xDSL, without inband POTS, it is necessary to separate the analogue POTS signal and the xDSL signal from each other at both the CO (Central Office) and the CP (Customer=s Premises). This can be achieved by using analogue passive high pass and low pass fitters. Figure 1, the accompanying drawing, illustrates this principle.

[0004] However, a passive POTS splitter design lacks the performance of an active splitter design, see J. Cook and P. Sheppard, "ADSL and VADSL Splitter Design and Telephony Performance", p. 1634, December 1995, IEEE Journal on Selected

Areas in Communications, ISSN 07-8716. This results in either:

———poorer POTS transmission; or

———if the cutoff frequency of the low pass filter in the splitter is increased, a waste of valuable spectrum that could otherwise be used to support higher data rates in the xDSL modem.

[0005] If an active POTS splitter design, with impedance matched circuits, is used, the filter design criteria become more reasonable while, at the same time, the spectrum, or bandwidth, use becomes more efficient, without degradation in the ordinary telephony transmission. The preferred solutions, especially as xDSL becomes, more common, is the active POTS splitter design, or inband POTS (which implements the telephony service as a part of the xDSL data stream).

[0006] If the active splitter design is used and the splitter is implemented on a single chip, the

present invention proposes the incorporation of test functionality for the line between the CP and the CO, or ONU (Optical Network Unit), on this chip. This enables two-sided measurements on the line, both during installation and during operation. The measurements are performed at the CO end upon request, or when the test device automatically sends a test message signal. In this way there will be no need for field technicians at the CP side. If necessary, these chips can have a unique identity code that is transmitted to the CO each time a test is started, or on receipt of a request from the CO.

[0007] The test messages/signals should either be specially designed for a certain measurement case, or general applicable signals which can be used with a range of tests, e.g. pulses, steps, or chirps, to estimate the transfer function of the line. One example of a parameter requiring two-sided measurement is attenuation. The test sequence could, in this case, be a series of sinusoidal signals, with known amplitudes, sent from the test device to the CO, in sequence. The sequence can, for example, comprise 10, 100, or any other number, of tones, starting from either low, or high frequency and then varying in frequency towards the other side of the frequency spectrum. Each tone is transmitted for a relatively long period of time, so that synchronisation is not a problem and so that the measurement can be performed within the duration of a tone. The start of a test may occur at a predetermined time interval after a test message request.

Summary of the Invention

[0008] According to a first aspect of the present invention, there is provided an active POTS splitter adapted to separate analogue POTS signals from xDSL signals, ~~characterized to that said~~wherein the active POTS splitter ~~incorporates~~includes line testing means.

~~Said~~[0009] The testing means may be adapted to transmit a test signal, or test message, to a line to be tested.

~~Said~~The test signal may be adapted for the performance of a specific line test.

Alternatively, ~~said~~the test signal may be of a general form capable of use with a range of different line tests.

~~Said~~The test signal may comprise at least one pulse.

~~Said~~ The test signal may comprise at least one step.

~~Said~~ The test signal may comprise at least one chirp.

~~Said~~[0010] The test signal may comprise a series of sinusoidal signals of known amplitude, each signal in ~~said~~the series having a different frequency, ~~said~~the series spanning a frequency range for which a line is to be tested.

Each tone of ~~said~~the series of sinusoidal signals may have a duration of a length sufficient to avoid problems associated with synchronisation and to permit a measurement to be completed within ~~said~~the duration.

~~Said~~[0011] The test means may be adapted to transmit ~~said~~the test signal, or message, on receipt of a request signal.

A test facilitated by ~~said~~the test means may be initiated at a predetermined time interval after receipt of a request signal by ~~said~~the test means.

~~Said~~ The test means may be adapted to transmit ~~said~~the test signal, or message, automatically.

~~Said~~ The test means may be adapted to transmit said test signal, or message, in accordance with a predetermined schedule.

~~Said~~**[0012]** The test means may have a unique identity code, and ~~said~~the test means may be adapted to transmit said unique identity code whenever a test signal, or message, is transmitted, or whenever an identification request signal is received.

~~Said~~The test means may be adapted to short-circuit a line.

~~Said~~**[0013]** The active POTS splitter, including ~~said~~the test means, may be implemented as a single chip.

~~Said~~The chip may be mounted on a PCB connected to a line jack adapted for direct insertion into a customer premises line socket.

[0014] According to a second aspect of the present invention, there is provided, in a telecommunications system adapted to employ xDSL and POTS, and comprising at least one central office connected to a plurality of subscribers by subscriber lines, a method of measuring quality parameters relating to xDSL transmission on a subscriber line, ~~characterised by~~including the steps of:

~~———~~ generating a test signal on ~~said~~the subscriber line at a subscriber=s premises;

———performing measurements at ~~said~~the central station on ~~said~~the test signal as received at ~~said~~the central station; and

———deriving quality parameters for ~~said~~the subscriber line from ~~said~~the measurements.

———

~~Said~~**[0015]** The test signal may be generated by causing the subscriber line to change form a high impedance state to a low impedance state. The test signal may be generated by causing a telephone to switch from an "on-hook" state to an "off-hook" state.

[0016] According to a third aspect of the present invention, there is provided, in a telecommunications system adapted to employ xDSL and POTS, and comprising at least one central office connected to a plurality of subscribers by subscriber lines, each subscriber premises being equipped with a POTS splitter, a method of measuring quality parameters relating to xDSL transmission on a subscriber line, ~~characterised by~~including the steps of:—

~~said~~ the POTS splitter generating a test signal on ~~said~~the subscriber line;—

performing measurements at ~~said~~the central station on ~~said~~the test signal as received at ~~said~~the central station; and

deriving quality parameters for ~~said~~the subscriber line from ~~said~~the measurements.

[0017] Said test signal may be adapted for the performance of a specific line test.

~~Said~~The test signal may be of a general form capable of use with a range of different line tests.

~~Said~~ The test signal may comprise at least one pulse.

~~Said~~ The test signal may comprise at least one step.

~~Said~~The test signal may comprise at least one chirp.

~~Said~~**[0018]** The test signal may comprise a series of sinusoidal signals of known amplitude, each signal in ~~said~~the series having a different frequency, ~~said~~the series spanning a frequency range for which a line is to be tested.

Each tone of ~~said~~the series of sinusoidal signals may have a duration of a length sufficient to avoid problems associated with synchroni~~s~~zation and to permit a measurement to be completed within ~~said~~the duration.

~~Said~~**[0019]** The test signal, or message, may be transmitted on receipt of a request signal.

A test may be initiated at a predetermined time interval after receipt of a request signal.

~~Said~~The test signal, or message, may be transmitted automatically.

~~Said~~ The test signal~~,~~ or message~~,~~ may be transmitted in accordance with a predetermined schedule.

[0020] Each POTS splitter may have a unique identity code, and ~~said~~the unique identity code may be transmitted whenever a test signal, or message, is transmitted, or whenever an identification request signal is received.

~~Said~~ The test signal may be generated by short-circuiting a line.

Results obtained from line tests may be collected and stored at ~~said~~the central office and a log of line condition for each subscriber line may be derived therefrom.

A plurality of results obtained from line tests may be collected and stored at ~~said~~the central office and ~~said~~the plurality of results may be averaged to obtain a composite result for each subscriber line.

[0021] According to a fourth aspect of the present invention, there is provided a telecommunications system adapted to employ POTS and xDSL, comprising at least one central office connected to a plurality of subscriber premises by subscriber lines, at least some of ~~said~~the subscriber premises having a POTS splitter located therein, ~~characterised in that said~~wherein the POTS splitter is a POTS splatter as set forth in any preceding paragraph.

[0022] According to a fifth aspect of the present invention, there is provided a telecommunications system adapted to employ POTS and xDSL, comprising at least one central office connected to a plurality of subscriber premises by subscriber lines, at least some of ~~said~~the subscriber premises having a POTS splitter

located therein, ~~characterised in that said~~wherein the POTS spotter is adapted to measure subscriber line quality in accordance with a method as set forth in any preceding paragraph.

Brief Description of the Drawings

[0023] Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawing, in which:

[0024] Figure 1 illustrates an overview of the way POTS splitters are located in an xDSL system.

Detailed Description of the Preferred Embodiments

[0025] As previously explained, when delivering a broadband service such as xDSL, without inband POTS, it is necessary to separate the analog POTS signal and the xDSL signal from each other at both the CO (Central Office) and the CP (Customers Premises). This can be done with analogue passive high pass and low pass filters and is illustrated in schematic form in Figure 1 which shows an overview of the principle. Referring briefly to figure 1, it will be seen that the CO has a rack of LICs (Line Interface Cards) which include POTS splitters for separating analogue telephony signals and xDSL signals received from subscribers. At the subscriber end, there is a POTS splitter which separates analogue telephone signals and xDSL signals received from the CO. This scheme is equally applicable to passive and active POTS splitters.

[0026] Unfortunately, passive POTS splatters lack the performance of active splitters. This results either in:

degradation of transmission; or

loss of xDSL spectrum.

The use of an active POTS splitter with impedance matched circuits gives more reasonable filter design criteria and more efficient use of xDSL spectrum.

[00027] The present invention proposes to capitalise on the advantages of active splitters by incorporating test functionality, for the line between the CP and the CO, or ONU (Optical Network Unit), in the POTS splitter and, preferably, implementing both the POTS splitter and test functionality in a single chip. This enables two-sided measurements on the line to be performed both during installation and operation. These measurements can be performed from the CO end either on request, or when the test device automatically sends a test message/signal. This avoids the need for field technicians at the CP side when line measurements are performed. The chip can be provided with a unique identity code that can be transmitted to the CO whenever a test is performed, or requested. The identity code can be associated with test data thus enabling a line to which the test data relates to be uniquely identified.

[00028] The test messages/signals are either specially designed for a certain measurement case or, alternatively, general test messages/signals such as pulses, steps, or chirps, that can be used to estimate the transfer function of the line. A parameter that demands two-sided measurement is attenuation. The test sequence can, in this case, be a series of sinusoidal signals, with known amplitude, sent from the test device to the CO in sequence. The sequence can, for example, comprise 10, or 100, or any other number of tones, starting from either low, of high, frequency and then going towards the other side of the frequency spectrum.

[00029] Each tone is sent out for a relatively long period of time, so that

synchronisation is not a problem. This also guarantees that the measurement is completed within the duration of a tone. The test commences at a predetermined time interval after receipt of a test message request.

[0030] Another valuable facility that can be provided by the test device is the ability to open, or short-circuit, the line at the CP side on request from the CO. This enables the well known open, or short-circuit measurement method, see SR Olofsson, Anders Isaksson & Joachim Johansson, "MEASUREMENT METHODS FOR WIRE PAIRS 1N THE ACCESS NETWORK", 7/0363/2/FCPA 1.0090013, 97-10-20, to be performed.

[0031] It is also possible to let the POTS splitter, located at the CP, generate a test signal every time the customer picks up the receiver, i.e. the telephone instrument changes from an "on-hook" state to an "off-hook" state. Measurements are performed on these signals at the CO and the results of the measurements accumulated, to this case the test signal can, for example, be a step, pulse, or even a chirp. It may even be possible to carry out these measurements without the test device by using the step signal that is generated whenever a telephone goes from an "on-hook" high impedance state to an "off-hook" low impedance state. However, if this method is to be used, care must, of course, be taken to handle the contact bounces that are generated. The central concept behind the invention is still to generate numerous test messages and to save the results at the CO.

[0032] Another possibility is to program the active POTS splitter to send certain test messages in

accordance with a predetermined schedule. At the CO side the LICs (Line Interface Cards) must have the functionality needed to measure and process the generated "on/off-hook" signal. If many such signals are collected and saved over a long period of time, the result can be used as a log of the line condition. A result calculated from a large set of accumulated data, i.e. many hook lifts, will naturally have higher precision than a result based on a single measurement.

[0033] In a typical application of the present invention, a customer calls Telia=s Customers Services Department, CSD, and requests that he/she be provided with Telia=s newly announced "Superinternet Service" i.e. Telia=s xDSL-service. The CSD tells the customer that they want to send him/her a test device, in other words, the active POTS splitter with line testing functionality, to check the quality of the sine. When the customer receives the POTS splitter, he/she can install it simply by inserting it in the telephony jack socket. It is then possible to perform measurements on the line from the CO. The results of these measurements can then be promptly sent to the customer. It may then be possible to deliver the service from the next day or, alternatively, some minor, or major, changes may have to be made to the network before the customer can be provided with the requested service. The test device and POTS spotter, of the present invention can be produced very cheaply because of chip integration. This means that it is not necessary to retrieve the test device and POTS splitter, from the customer, if the line quality is insufficient for the provision of an xDSL service.

[00034] POTS splitters that separate the analogue POTS signal and the xDSL signal from each other are, advantageously, alive, because of the inadequate performance of passive designs. Active POTS splitter can be realised on a single chip, so that a POTS splitter solution only requires one IC on a simple circuit board. At very little additional cost it is possible to implement testing functionality on this chip. With this functionality it is possible to send test messages from the test device/POTS splitter at the CP, upon receipt of a request from the CO end. At the CO end, measurements of the line quality can then be performed. When a customer asks for an xDSL, or other copper line based broad band service, the test device/POTS splitter can be sent to the customer's home and the customer can then install the POTS splitter test device himself. The test device/POTS splitter is a low cost device which means that it can be sent to customers free of charge and customers can be allowed to keep these devices even if measurements ~~performedit~~performed indicated that it is not possible to install any broad band service. It is also possible to automatically, generate test signals from the test device/POTS spotter, e.g. on every "hook lift@, in order to get large numbers of test results that are accumulated at the CO side, possibly on modified Line Interface Cards, thus yielding better estimates of the line condition.